

CLAIMS

What is claimed is:

1. A charge pump circuit comprising:
 - charge pumping capacitance;
 - switches that vary voltage across the pumping capacitance to provide a pumped output voltage from an input voltage;
 - variable resistance; and
 - control that varies the variable resistance with varied operating point.
- 10 2. A charge pump as claimed in claim 1 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.
3. A charge pump as claimed in claim 1 wherein the variable resistance comprises a switch coupled in parallel with a resistor.
- 15 4. A charge pump as claimed in claim 3 wherein the switch is a field effect transistor.
5. A charge pump as claimed in claim 3 wherein the control comprises a comparator.
- 20 6. A charge pump as claimed in claim 3 wherein the control comprises an amplifier.
- 25 7. A charge pump as claimed in claim 3 wherein the control comprises a shunt reference device.
8. A charge pump as claimed in claim 1 wherein the variable resistance comprises a field effect transistor.

9. A charge pump as claimed in claim 1 wherein the control comprises a comparator.
10. A charge pump as claimed in claim 1 wherein the control comprises an amplifier.
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11. A charge pump as claimed in claim 1 wherein the control comprises a shunt reference device.
12. A controller comprising:
10 charge pumping capacitance;
switches that vary voltage across the pumping capacitance to provide a pumped output voltage from an input voltage;
variable resistance; and
control that varies the variable resistance with varied operating point.
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13. A controller as claimed in claim 12 comprising both a charge pump internal to a controller integrated circuit and an external charge pump.
14. A controller as claimed in claim 12 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.
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15. A controller as claimed in claim 12 wherein the variable resistance comprises a switch coupled in parallel with a resistor.
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16. A controller as claimed in claim 15 wherein the switch is a field effect transistor.
17. A controller as claimed in claim 15 wherein the control comprises a comparator.
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18. A controller as claimed in claim 15 wherein the control comprises an amplifier.

5 19. A controller as claimed in claim 15 wherein the control comprises a shunt reference device.

20. A controller as claimed in claim 12 wherein the variable resistance comprises a field effect transistor.

10 21. A controller as claimed in claim 12 wherein the control comprises a comparator.

15 22. A controller as claimed in claim 12 wherein the control comprises an amplifier.

23. A controller as claimed in claim 12 wherein the control comprises a shunt reference device.

20 24. A DC/DC converter comprising:
controlled switches; and
a controller that controls the controlled switches, the controller comprising:
charge pumping capacitance;
switches that vary voltage across the pumping capacitance to provide a pumped output voltage to the controller from an input voltage;
variable resistance; and
control that varies the variable resistance with varied operating point.

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25. A DC/DC converter as claimed in claim 24 comprising both a charge pump internal to a controller integrated circuit and an external charge pump.

5 26. A DC/DC converter as claimed in claim 24 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.

27. A DC/DC converter as claimed in claim 24 wherein the variable resistance comprises a switch coupled in parallel with a resistor.

10 28. A DC/DC converter as claimed in claim 27 wherein the switch is a field effect transistor.

29. A DC/DC converter as claimed in claim 27 wherein the control comprises a comparator.

15 30. A DC/DC converter as claimed in claim 27 wherein the control comprises an amplifier.

20 31. A DC/DC converter as claimed in claim 27 wherein the control comprises a shunt reference device.

32. A DC/DC converter as claimed in claim 24 wherein the variable resistance comprises a field effect transistor.

25 33. A DC/DC converter as claimed in claim 24 wherein the control comprises a comparator.

34. A DC/DC converter as claimed in claim 24 wherein the control comprises an amplifier.

35. A DC/DC converter as claimed in claim 24 wherein the control comprises an shunt reference device.

36. A method of charge pumping comprising:
5 varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage; and
varying variable resistance in circuit with the pumping capacitance with varied operating point.

10 37. A method as claimed in 36 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.

38. A method as claimed in 36 wherein the variable resistance comprises a field effect transistor.

15 39. A method as claimed in 36 wherein the variable resistance is varied in response to a comparator.

20 40. A method as claimed in 36 wherein the variable resistance is varied in response to an amplifier.

41. A method as claimed in 36 wherein the variable resistance is varied in response to a shunt reference device.

25 42. A method of converting DC voltage to DC voltage comprising:
varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage;
varying variable resistance in circuit with the pumping capacitance with varied operating point;
30 applying the output voltage to a controller; and

controlling converter switches from the controller.

43. A method as claimed in 42 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.

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44. A method as claimed in 42 wherein the variable resistance comprises a field effect transistor.

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45. A method as claimed in 42 wherein the variable resistance is varied in response to a comparator.

46. A method as claimed in 42 wherein the variable resistance is varied in response to an amplifier.

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47. A method as claimed in 42 wherein the variable resistance is varied in response to a shunt reference device.

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48. A charge pump comprising:

means for varying voltage across a pumping capacitor to provide a

pumped output voltage from an input voltage; and

means for varying variable resistance in circuit with the pumping capacitance with varied operating point.

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49. A controller comprising:

means for varying voltage across a pumping capacitor to provide a

pumped output voltage from an input voltage; and

means for varying variable resistance in circuit with the pumping capacitance with varied operating point.

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50. A DC/DC converter comprising:

- means for varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage;
- means for varying variable resistance in circuit with the pumping capacitance with varied input voltage;
- means for applying the output voltage to a controller; and
- means for controlling converter switches from the control.